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Make each homogeneous set of terms equal to a summand of the absolute term. Operate on these by A-D, and add the results.

$$\begin{array}{lll} \text{Example. } xy+x+y=a. & xy=p, & x_1y+xy_1=2p \\ & x+y=q, & x+x_1+y+y_1=2q \end{array}$$

Whence  $x_1y+xy_1+x+y+x_1+y_1=2x_1y_1+2x_1+2y_1$ , and  $x_1y+xy_1+x+y-x_1y_1=a$ .

$$\begin{array}{lll} \text{Example. } xy+x=1. & xy=p, & xy_1+x_1y=2p \\ & x=q, & x+x_1=2q \end{array}$$

Whence  $x_1y+xy_1+x+x_1=2(p+q)=2$ .

$$\begin{array}{lll} \text{Example. } x^2+y^2+xy=1. & x^2+y^2=p, & 2(xx_1+yy_1)=2p \\ & xy=q, & xy_1+x_1y=2q \end{array}$$

Whence  $xy_1+x_1y+2xx_1+2yy_1=2$ .

$$\begin{array}{lll} \text{Example. } x^2+xy=a. & x^2=p, & 2xx_1=2p \\ & xy=q, & xy_1+x_1y=2q \end{array}$$

Whence  $x_1y+xy_1+2xx_1=2a$ .

## PROOF THAT FOR MAXIMUM CURRENT THE EXTERNAL AND INTERNAL RESISTANCES SHOULD BE EQUAL.

By JAMES S. STEVENS, Professor of Physics, University of Maine, Orono, Me.

If we have  $a$  cells to connect we may take  $m$  series with  $n$  cells in each series. Then  $mn=a$ .

By formula for Ohm's law,

$$C = \frac{nE}{\frac{nr}{m} + R}$$

where  $r$  and  $R$  are respectively the internal resistance of each cell and the total external resistance.

Dividing numerator and denominator by  $n$  we have

$$C = \frac{E}{\frac{r}{m} + \frac{R}{n}}$$

For maximum current it is necessary to make  $\frac{r}{m} + \frac{R}{n}$  a minimum.

The expression takes the following form :

$$\frac{R}{n} + \frac{r}{a/n}, \quad \frac{aR + rn^2}{an}.$$

Placing the first differential coefficient of this expression equal to zero we have

$$\frac{2an^2 r dn - a^2 R dn - an^2 r dn}{a^2 n^2} = 0.$$

From which

$$rn^2 = aR, \quad n^2 = \frac{aR}{r}.$$

Replacing the value of  $a/m$  for one factor in  $n^2$ ,

$$n \frac{a}{m} = \frac{aR}{r}, \quad \frac{n}{m} = \frac{R}{r}, \quad R = \frac{n r}{m}.$$

Or the external resistance equals the total internal resistance. This is seen to be a minimum value for the expression differentiated since the value of the second differential coefficient is greater than zero for the positive value of  $n$ , —the only value it can have.

## THE RADIUS OF THE TERRESTRIAL SPHEROID.

By F. P. MATZ, M. Sc., Ph. D., Professor of Mathematics and Astronomy in Irving College, Mechanicsburg, Pa.

If there be nothing *new* under the sun, it may not be uninteresting to expand the *old*.

Represent the earth's equatorial radius by  $a$ , the geographical latitude by  $\phi$ , and the geocentric latitude by  $\phi'$ ; then since  $x^2/a^2 + y^2/b^2 = 1$ , we have  $\tan \phi = -dx/dy$ , and  $\tan \phi' = y/x$ . Also, since  $b^2 = a^2(1 - e^2)$ , we have

$$y^2 = a^2(1 - e^2) - (1 - e^2)x^2 \text{ and } y/x = (1 - e^2)\tan \phi.$$

$$\therefore x = \frac{a \cos \phi}{\sqrt{1 - e^2 \sin^2 \phi}} \text{ and } y = \frac{a(1 - e^2) \sin \phi}{\sqrt{1 - e^2 \sin^2 \phi}} \dots (1).$$

Now, the radius of the terrestrial spheroid for any latitude  $\phi$ , is  $\rho = \sqrt{x^2 + y^2}$ .

$$\therefore \rho = a \sqrt{\left(1 - \frac{e^2(1 - e^2) \sin^2 \phi}{1 - e^2 \sin^2 \phi}\right)}, = a \sqrt{[1 - e^2(1 - e^2)(\sin^2 \phi + e^2 \sin^4 \phi)]}.$$

By assuming  $e^2 = 1 - f^2$  and  $\sin^2 \phi = \frac{1}{2}(1 - \cos 2\phi)$ , Encke obtains the series